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Phytochemical, physical and functional properties of flour blends produced from wheat, unripe plantain and pigeon pea

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Abstract

This study investigated the phytochemical, physical and functional properties of flour blends produced from wheat, unripe plantain and pigeon pea, suitable for purposes of formulating food composition table for the flour blends by homogenously mixing wheat, pigeon pea and unripe plantain flour in the proportion of wheat flour (100%) 100:0 (WHF), wheat-pigeon pea flour 95;5:0 (WPF),wheat-unripe plantain-pigeon pea flour 85:10.5 (WPU_1), wheat-unripe plantain-pigeon pea flour 75:15:10 (WPU_2)and 65:20:15 (WPU_3) respectively. WHF represent 100% wheat flour served as control. There was a significant difference ($p<0.05$) among samples of flour blends (WHF), (WPF),(WPU1), (WPU_2) and (WPU_3).The results obtained for proximate composition, phytochemical and functional analysis ranged: crude fiber (2.90-4.07%), protein (10.10-14.50%), moisture (5.00-10.50%), ash (0.50-0.7%), fat (2.04-3.50%), carbohydrate(67.95-79.26%), saponins (0.46-2.97 mg/100g), flavonoids (4.50-4.70 mg/100g), tannins(0.80-1.26 mg/100g) phenols (1.00-1.50 mg/100g), bulk densities (0.41-8.20g/cm3), emulsion capacity (9.20-5.20%), foaming capacity (2.90-10.60%), water absorption capacity (6.20-6.60g/g), oil absorption capacity (0.10-8.50%) and swelling capacity (25.00-29.00%) respectively. The results showed that incorporation of pigeon pea flour into wheat flour significantly ($p>0.05$) increased the protein, fibre and fat content of composite flour. As the ratio of wheat decreases and increase in the unripe plantain and pigeon pea, the carbohydrate content decreases significantly. WHF shows higher carbohydrate content among samples. This is evident that wheat has high carbohydrate content. Based, on the result from this study, it can be concluded that flour formulation from different four blends can improve the nutritional values of flour blends and reduce anti-nutrients drastically.

Keywords: Composite flour; Flour blends; Functional properties; Phytochemical; Proximate composition

1. Introduction

The intense search for an alternative protein sources is a major challenge in Africa and Nigeria, owing to the fact that animals and animal products (such as eggs, milk, meat and fish) are unaffordable as source of nutrients [1]. Consequently, the effort of enhancing the potential of some underutilized and lesser known plant materials as industrial raw material for food application in Nigeria continues to receive significant attention as human population continued to grow.

Wheat flour is a staple in human nutrition and is the main flour used for the manufacture of baked products. This is due to the fact that wheat flour is easily pliable and has all the qualities required of a flour material for baking. However, wheat flour is expensive to import and the crop cannot be grown in Nigeria because her soil and climate are not favourable to its cultivation. In recent years, researchers in Nigeria have tried earnestly and persistently to focus on the use of inexpensive and available flours from local raw materials to supplement wheat flour in the production of baked products.

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Plantain known as *Musa paradisiaca* is a member of *Musaceae* family and genus *Musa.* Food producers might be faced with challenges of producing food products containing functional ingredients to meet nutritional requirements of individuals with health challenges. Plantain has been shown to be excellent for weight control, slow in the release of energy after consumption with a low glycermic index [2] , high in resistant starch, potassium and good for diabetic patients [3]. It is a major staple food crop in the humid and sub-humid parts of Africa and provider of energy for millions of people in these regions. It is a tropical plant that is native to India and known in English as plantain, Yoruba as '*Ogedeagbagba'*, Hausa *'Ayaba'* and Igbo '*Ogadejioke'* [4]. Plantain is a popular dietary staple due to its versatility and good nutritional value. It is starchy, less sweet variety of banana that can be used either ripe or unripe. It is a good source of energy having carbohydrate of about 32% of the total fruit weight comparable in nutritive value to yam or potato and also rich in iron, dietary fibre, calcium, vitamin A, B6 and C [5,6]. Most plantain foods are eaten as boiled, fried or roasted, and flour produced from unripe plantain is used traditionally for the preparation of a thick paste (Amala). Nutritionally, plantain fruit possessed carbohydrates, minerals, amino acids, fibre, and carotenoids.

Legumes generally contain high amount of protein compared to other plant food stuffs. Legume proteins are mainly used in food formulations to complement for protein in cereal grains because of their chemical and nutritional characteristics [7]. Pigeon pea (*Cajanus cajan*) is a valuable source of low-cost vegetable protein, minerals and vitamins and occupies a very important place in human nutrition [8, 9, 10].

The use of pigeon pea in the supplementation of starchy foods has been reported [11,12,13] but lesser work has been done on incorporating plantain flour. Pigeon pea has been examined and discovered to be an appropriate protein source for supplementing baked products due to its high protein, iron and phosphorus content and the sensory attributes of the products are not altered. But pigeon pea contains anti nutrients which is a limitation to its use. To improve its nutritional composition, pigeon pea seeds are subjected to a combination of fermentation and sprouting processing methods. Fermentation is an economic method that could be used to improve the nutritional quality of plant foods. According to [14] fermentation improves digestibility and nutritional quality. Sprouting improves digestibility, bioavailability of vitamins, minerals, amino acids, proteins, Pigeon pea can be used to supplement wheat flour for the production of baked and other products. This will reduce the quantity of wheat flour importation and conserve foreign exchange. In addition, this will encourage the large scale cultivation and utilization of pigeon pea.

Phytochemicals is a bioactive nutrient plant chemicals found in fruits, vegetables, grains, and other plant foods that may provide desirable health benefits beyond basic nutrition to reduce the risk of major chronic diseases [15]. Phytochemicals reduce anti-nutrients starch of cereals and legumes thereby increasing the absorption of protein and iron [16]. Phytochemicals have great antioxidant potential and are of great interest due to their beneficial effects on health of human beings, and they give immense health benefits to the consumers. The utilization of flour blends from wheat and unripe plantain and pigeon pea will lead to improvement of nutritional composition of the flour; also the use of composite flour blends from wheat, unripe plantain and pigeon pea can aid to reduce malnutrition and can also create more market for the raw material. Some researchers had carried out some studies on the effects of combined processing methods on functional properties of pigeon pea flour, but information on the effects of supplementation of combined sprouted/fermented pigeon pea, unripe plantain flour and wheat flour on the phytochemical, physical, functional properties are scarce hence this study.

2. Material and methods

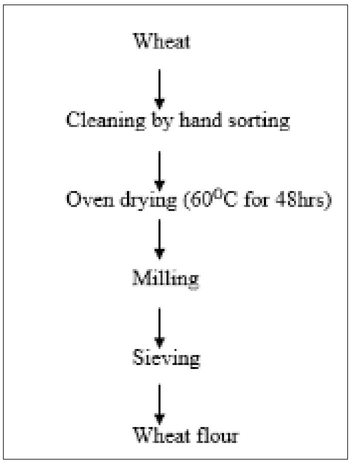
2.1. Materials

Wheat, unripe plantain and pigeon pea were purchased from new market in Wukari, Taraba, State, Nigeria. The samples were conveyed to Food Science and Technology laboratory Federal University Wukari where the analyses was carried out.

2.2. Methods

2.2.1. Wheat Flour Production

According to the description by [17], wheat grains were cleaned manually by handpicking the chaff, dust, stones were removed by washing in clean water (sedimentation). The washed and stone free grains were oven dried "45 ^{o}C" for 3hours and then milled using milling machine (model R175A). The flour was sieved using (0.3mn aperture) sieve, packaged (polyethylene) and stored under room temperature.

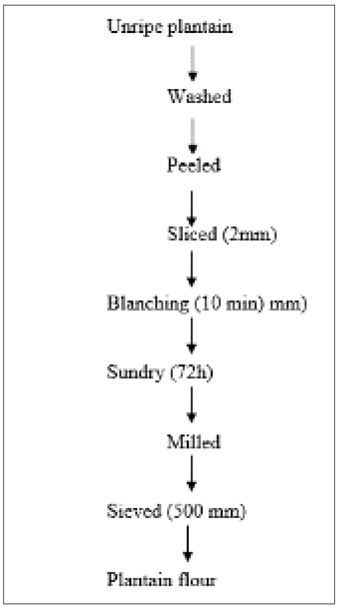


Source: Ayo et al (2007)

Figure 1 Production of wheat Flour

2.2.2. Unripe Plantain Flour

Fresh matured unripe plantain was washed, hand-peeled and sliced into pieces about 5-10 mm thick and then steam blanched (Hughes Blancher Model:02-1471) for 3min. The sliced plantain was sun dried at 72 h and milled using attrition mill (Inch15HP Super 150-180 Kilogram Tw-HM-1016) and sieved (0.3µm aperture size). Packaged in a polyethylene bag and stored (at temperature 5^{o}C). The procedure is shown in Fig 2 [18].

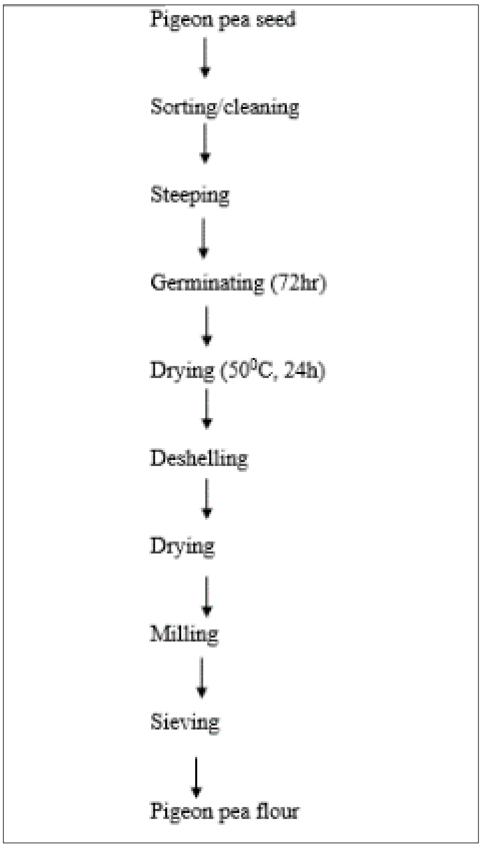


Source: China *et al.*, 2020a[18]

Figure 2 Production of flour from unripe plantain

2.2.3. Pigeon pea Flour

According to the description by [19] the pigeon pea seeds was sorted and washed. The seeds was then steeped in water at "29 °C " for 24 hours. Changing of water at 6 hours interval was observed during steeping. The resultant steeped seeds was spread on jute bag and covered with white cotton cloth to germinate for 72 hours. The sprouted seeds was sun dried for 72 hour and thereafter, the plumules was separated from the seed and the malted seeds was dried and milled into flour using milling machine (model R175A) [19].



Source: China *et al*., 2022 with some modifications[19].

Figure 3 Production of legumes pigeon pea flour

2.2.4. Composite Flour Preparation (Wheat-Unripe Plantain and Pigeon pea)

Wheat, pigeon pea and plantain composite flour was blended in the ratio of 100:0:0, 95:5:0, 85:10:5, 75:15:10, 65:20:15.

Preparation of Flour blends

Table 1 Sample Formulation

Sample ID (%)					
Flour	**WHF**	**WPF**	**WPU1**	**WPU2**	**WPU3**
Wheat	100	95	85	75	65
Pigeon pea	0	5	10	15	20
Unripe plantain	0	0	5	10	15

2.3. Analytical Methods

2.3.1. Functional Properties

The functional properties of flours blends were determined using the following standard methods.

Bulk Density

Bulk density is the weight of a volume unit of powder and is usually expressed in g/cm^3, kg/m^3 or g/100ml.Bulk density was determined according to the method described by [20].Ten grams (10g) of the sample was weighed into a “25ml” graduated measuring cylinder and gently tapped continuously on a laboratory table to eliminate spaces between the flour particles until a constant volume was obtained.

Water Absorption Capacity

Water absorption capacity refers to the ability of flour to absorb water immersed in it. A modified method as described by [12] was used.

Oil Absorption Capacity

Oil absorption capacity is defined as the difference in the flour weight before and after its absorption. This was carried out according to the method described by [22]. One gram ("1 g") of flour was mixed in 10ml of oil and centrifuged at 3500rpm using spectra scientific centrifuge (Model: Merlin, SN976137) for 30min before the excess oil was decanted and the tube was inverted over an absorbance paper to drain dry.

Emulsion Capacity

Emulsion capacity is the ability of sufficiently soluble proteins to migrate to the water / oil interface, and environmental conditions. This was determined by the method described by [23]. One gram ("1g") of flour was blended with 10ml of distilled water and 10ml of soybean oil in calibrated centrifuge tube. The emulsion was centrifuged at 2000 x g for 5min. The ratio of the height of emulsion layer to the total height of the mixture was calculated as emulsion capacity in percentage.

Foam Capacity

According to [20], Foam capacity is the amount of interfacial area that can be created by flour. One gram ("1 g") of flour sample was blended with 50ml of distilled water in a warring blender for 5 min at room temperature to foam. The mixture was carefully transferred to the measuring cylinder, allow to stand for 1hr and the foam volume was measured and recorded for foam capacity.

Pasting Properties

Pasting properties was determined with a Rapid Visco Analyzer (RVA) (Model RVA 3DH, Newport Scientific Australia) as describe by [24]. Twenty-five grams ("25 g") of each sample was weighed into a dried empty canister, "25 ml" of distilled water was added and thoroughly mixed. The slurry was heated to 95 ^{0}C with a holding time of 2 minutes followed by cooling to 50^{0}C with 2 min holding time. Peak viscosity, trough viscosity, breakdown viscosity, final viscosity, setback viscosity, pasting temperature and peak time was read from the pasting profile with the aid of a thermocline.

2.3.2. Phytochemical analysis

The phytochemical properties of the flour blend were carried using standard methods.

Flavonoid determination

The flavonoid content was determined by the method described by [25]. Five grams (5g) of the ground sample was weighed in a 250 ml titration flask and 100 ml of 80 % aqueous methanol was added and shaken for 4 h in an electric shaker. The entire solution was filtered through Whatman number 1 filter paper. The filtrate was transferred into a crucible and evaporated to dryness over a water bath.

Saponin determination

The saponin content was determined using the spectrophotometric method as described by[27]. Two grams (2g) of the flour sample was weighed into a conical flask and 100 ml of isobutyl alcohol added and shaked using laboratory shaker for 5h to ensure uniform mixing. The mixture was filtered and 20 ml of 40% saturated solution of MgCO added after which it was filtered again with Whatman No. 1 filter paper to get a clean colourless solution. 1 ml of the colourless solution and 2 ml of 5% FeCl solution was added together and made up to the mark with distilled water and allowed to stand for 30 min for colour development. Absorbance was measured against the blank at 380 nm.

Tannin determination

The tannin content was determined with the method described by [28]. Two hundred and fifty milligram (250 mg) of the sample (after the pigments and fat have been removed with diethyl ether containing 1% acetic acid) was taken into 10 ml of 70% aqueous acetone for extraction for 2 h at 30^{0}C using a water-bath. The total polyphenols (as tannin) was determined using Folin Ciocalteau reagent and 2.5 ml sodium carbonate solution. Absorbance was measured at 725 nm. The total polyphenols (as tannin) was calculated using the standard curve.

Phenol Content Determination

Total phenolic content was determined as described by Folin–Ciocalteu's method[29] using spectrophotometric method.

2.4. Proximate Composition

The proximate composition of the flour blends were assessed. Total ash was determined as described by AOAC [29]. For each flour blends 5g of the sample was heated in a furnace at 550^{0}C, for 6 h. The total carbohydrate content was calculated by difference as described by AOAC [30]. % Carbohydrate = 100 – (% moisture + %fat + % protein +% ash).The Kjeldahl method was used for the determination of crude protein as described by [29]. The samples (1.0 g) each were digested in Kjeldahl digesting system. The total protein was calculated by multiplying N (the total nitrogen) with 6.25 as the conversion factor. Total moisture was determined as described by [31]. For each flour blends 5grams was dried in hot air oven at 105 ^{0}C till constant mass. The total fat content was determined using the Rose-Gottlieb Method as described by AOAC [29].

2.5. Statistical Analysis

All the analyses was conducted in triplicates in completely randomized design. The data was subjected to analysis of variance with Duncan's New Multiple Range Test (DNMRT), using Statistical Package for Social Science (SPSS) software version 23, 2017. Means was significantly different and separated by the least significant difference (LSD) test. All statistical tests was performed at a 5% significance level and Significance was accepted at $p<0.05$ and was expressed as mean $\pm$ standard deviation of triplicate values.

3. Results and discussion

3.1. Proximate Composition of Composite Flour

Proximate composition of composite flour produced from wheat, unripe plantain and pigeon pea is presented in Table 4.1. There was a significant difference ($p<0.05$) among samples of wheat flour (100%) (WHF), wheat-pigeon pea flour (95:5:0) (WPF), wheat-unripe plantain-pigeon pea flour (85:10:5) (WPU1), wheat-unripe plantain-pigeon pea flour (75:15:10) (WPU2) and wheat-unripe plantain-pigeon pea flour (65:20:15) (WPU3) in terms of moisture, ash, protein, and carbohydrates.

Moisture content ranged from 5.00-10.50 for samples WHF-WPU3. WHF shows lower value and WPU3 shows higher moisture content among the composite flour samples. The lower moisture content of WHF leads to higher ash content in WHF. Higher moisture content in WPF, WPU1, WPU2 and WPU3 also leads to lower ash content in WPF, WPU1, WPU2 and WPU3. This may be due to the volatility of some minerals which evaporated during the drying process of the flours. The result obtained from this study is in agreement with [32] who reported a similar result for pigeon pea, sweet potato and wheat flour composite flour.

Ash content ranged from 0.50-0.70%. Increase in unripe plantain and pigeon pea flour ratio of flour increase the protein, fiber and fat content of the composite flour. WHF shows higher values. Result obtained for this study does not corroborate with the findings of [33] who reported a high ash content of wheat flour supplemented with pigeon pea flour. The variation in result could be due to difference in species of wheat and pigeon pea or inclusion of unripe plantain flour. Similar result was reported by [34] for wheat and pigeon pea flour composite flour.

The results for fat content ranged from 2.04-3.50%. The result showed that incorporation of pigeon pea flour into wheat flour significantly ($p>0.05$) increased the fat content of composite flour. The fat content obtained in this study is in agreement with the findings of [35] who reported a similar fat content in wheat and millet-pigeon pea flour blends.

Carbohydrate content of the wheat, unripe plantain and pigeon pea flour ranged from 67.95-79.26%. WHF shows higher carbohydrate content among samples. This is evident that wheat has high carbohydrate contents. As the ratio of wheat decreases and increase in the unripe plantain and pigeon pea, the carbohydrate content decreases significantly. The result obtained in this study is in agreement with the findings of Bello et al. (2019) who reported a similar carbohydrate content of wheat, pigeon pea and plantain composite flour.

Table 2 Proximate Composition of Composite Flour (%)

Sample code	Ratio	Moisture	Ash	Protein	Fibre	Fat	Carbohydrate
WHF	100:0	$5.00^{b}±0.00$	$0.70^{a}±0.14$	$10.10^{b}±1.41$	$2.90^{a}±0.14$	$2.04^{a}±0.01$	$79.26^{a}±0.01$
WPF	95:5:0	$10.00^{a}±1.41$	$0.50^{b}±0.14$	$11.50^{b}±1.41$	$3.00^{a}±1.14$	$2.05^{a}±0.03$	$72.95^{b}±0.01$
WPU1	85:10:5	$10.00^{a}±2.83$	$0.50^{b}±0.14$	$11.50^{b}±1.41$	$3.05^{a}±0.01$	$3.00^{a}±1.41$	$71.95^{c}±0.01$
WPU2	75:15:10	$10.00^{a}±1.41$	$0.50^{b}±0.14$	$13.50^{a}±0.00$	$3.53^{a}±0.01$	$3.00^{a}±1.41$	$64.47^{d}±0.01$
WPU3	65:20:15	$10.50^{a}±0.14$	$0.50^{b}±0.14$	$13.50^{a}±1.41$	$4.07^{a}±0.01$	$3.50^{a}±0.00$	$67.95^{e}±0.01$

The data are means ±standard deviations of duplicate scores. Means within a row with different superscripts were significantly different (p<0.05).

WHF-wheat flour, WPF- wheat and pigeon pea flour, WPU-wheat, pigeon pea and unripe plantain flour.

3.2. Functional Properties of Composite Flour

Table 4.2 showed the functional properties of composite flour. There was significant ($p < 0.05$) difference in the functional properties of composite flour. There was significant ($p < 0.05$) difference between the swelling capacity of composite flour samples.

Swelling index determines the amount of water food samples would absorb and the degree of swelling within a given time. The swelling capacity of WPU3 was the highest while WHF and WPF had the least value. This is evident that unripe plantain is responsible for the increase in the swelling capacity of the composite flour. Similar swelling capacity was reported for wheat and millet-pigeon composite flour by [35].

The bulk densities (BD) of the flour samples, which measures how dense a flour sample is, ranged between 0.41g/cm3 for sampleWPU3 to 8.20g/cm3 for sampleWPU1.[35] reported a higher result for wheat and millet-pigeon composite flour. The variation in result could be due to the inclusion of unripe plantain in this study. The high bulk densities of the flour samples may be an advantage since it may allow for ease of dispensability reduced paste thickness during reconstitution [36], but may enhance packaging, storage and transportation costs [37].

Emulsion capacity increases with an increase in the incorporation of the flour blends. 9.20% was recorded for WPU3 and 5.20% was recorded for WHF. [33] reported higher result of wheat flour supplemented with pigeon pea flour. The variation in result could be due to low proteins which show superior binding of lipids [38].

There was significant decrease ($p < 0.05$) in the oil absorption capacity as ratio of unripe plantain and pigeon pea flour incorporated in to the flour samples increased. The oil absorption capacity of WPU1 was higher having 8.50 g/cm3 while that of WPF was the least having 0.1g/cm3. The lower oil absorption capacity of composite flour for samples of WHF, WPF, WPU1, WPU2 and WPU3 may be due to low hydrophobic proteins which show superior binding of lipids [38].

Table 3 Functional Properties of Wheat, Unripe Plantain and Pigeon Composite Flour

Sample code	Ratio	SC	BD (g/mL)	EC (g/mL)	OAC (g/mL)	FC (g/mL)	WAC (g/mL)
WHF	100:0	$25.00^{c}±0.00$	$0.50^{b}±0.28$	$5.20^{b}±1.41$	$0.20^{bc}±0.00$	$2.90^{c}±0.14$	$8.00^{e}±0.00$
WPF	95:5:0	$25.00^{c}±1.41$	$0.50^{b}±0.14$	$8.20^{a}±1.41$	$0.10^{c}±0.00$	$4.80^{b}±0.14$	$9.4^{d}±0.14$
WPU1	85:10:5	$26.00^{ab}±0.00$	$8.20^{a}±0.14$	$8.20^{a}±0.0$	$8.50^{a}±0.14$	$10.50^{a}±0.14$	$10.50^{c}±0.14$
WPU2	75:15:10	$27.00^{ab}±0.00$	$0.42^{b}±0.01$	$8.30^{a}±0.14$	$0.40^{b}±0.14$	$9.00^{a}±1.41$	$11.20^{b}±0.14$
WPU3	65:20:15	$29.00^{a}±0.00$	$0.41^{b}±0.14$	$9.20^{a}±0.14$	$0.40^{b}±0.14$	$10.60^{a}±0.14$	$11.80^{a}±0.14$

The data are means± standard deviations of duplicate scores. Means within a row with different superscripts were significantly different (p<0.05).; SC – Swelling Capacity, BD – Bulk Density, EC – Emulsion Capacity, OAC – Oil Absorption Capacity, FC – Foaming Capacity, WAC – Water Absorption Capacity.

Foaming capacity (FC) significantly ($p<0.05$) ranged from 2.90-10.60% with the least value found in WHF while WPU3 gave the highest value. The findings of [39] were higher as compared to this study. The variation may be due to high protein content obtained in this study.

Water absorption capacity ranged from 6.20-6.60 g/g. Addition of unripe plantain flour had no significant effect on the water absorption capacity of the blends. The water absorption capacity was higher in WPU3 and least in WHF. The variation in water absorption capacity of the flour may be due to the concentration of protein, degree of interaction with water conformational characteristics [40]. High water absorption values of flours have been associated with high moisture, protein, and fibre contents, due to their high hydration properties [41]. The result for this study is higher that the findings of [39] on wheat, pigeon peas and unripe plantain flour blends. The variation in result could be due to varieties of crop species.

3.3. Pasting Properties of Composite Flour

Table 4.3 depicts the pasting properties of composite flour as measured in Rapid Visco Units (RVU). The peak viscosity ranged from 297.10–379.29 RVU with the sample WPU1 recording the highest value. Peak viscosities of the samples significantly ($p < 0.05$) decreased from 379.29 RVU for WPU1 sample to 3001.00 RVU for the 5% pigeon pea flour substituted sample and then increased progressively to a maximum of 379.29 RVU for the 5% plantain flour substituted sample. Peak viscosity is the maximum viscosity attained during or immediately after heating. It is associated with degree of starch damage and high starch damage results to high peak viscosity [42]. Peak viscosity indicates the water holding capacity of starch and is often correlated with the final product quality.

Trough viscosity is the minimum viscosity value that measures the ability of paste to withstand breakdown during cooling[33]. WPU2 sample recorded the least trough viscosity value (159.46 RVU) while WPU1 sample exhibited the highest value (201.85 RVU). The value for the control sample was 187.25 RVU. Trough increased as the percentage inclusion of unripe plantain flour was added. This may be due to the swelling capacity of the starch granules in unripe plantain flour [43]. Breakdown point is the difference between the peak viscosity and trough viscosity and measures the tendency of swollen granules to rupture when held at high temperature and continuous shearing[24]. Breaking point increased significantly ($P<0.05$) with increase in 5% unripe plantain flour. Values ranging from 117.95 RVU for the control sample to 177.40 RVU for WPU1 sample. . Final viscosity is the parameter used to determine the quality of a starch-based sample. It gives an idea of the ability of starch to gel after cooking and cooling [23]. This suggests that the blends of wheat flour supplemented with combined processed pigeon pea flour with low final viscosities will be more stable after cooling. Final viscosity ranges from 214.70-270.50 RVU with WPU1 and WHF having the higher value and WPU2 has the lower value.

Table 4 Pasting Properties of Wheat, Unripe Plantain and Pigeon Composite Flour

Sample code	Ratio	Peak	Trough	Breaking Point	Final Viscosity	Set Back	Peak Time	Pasting Temperature
WHF	100:0	$305.29^{b}\pm1.41$	$187.25^{c}\pm1.41$	$117.95^{d}\pm1.41$	$270.50^{a}\pm0.00$	$72.67^{c}\pm0.01$	$5.47^{b}\pm0.00$	$74.50^{b}\pm0.00$
WPF	95:5:0	$300.01^{c}\pm0.14$	$192.35^{b}\pm1.41$	$107.65^{e}\pm0.00$	$259.60^{b}\pm0.02$	$66.65^{d}\pm0.00$	$5.50^{a}\pm0.00$	$74.10^{c}\pm0.14$
WPU1	85:10:5	$379.29^{a}\pm1.41$	$201.85^{a}\pm1.41$	$177.40^{a}\pm0.0$	$270.50^{a}\pm0.00$	$72.67^{c}\pm0.00$	$5.47^{b}\pm0.01$	$72.50^{d}\pm0.14$
WPU2	75:15:10	$297.10^{d}\pm0.14$	$159.46^{e}\pm0.01$	$137.45^{b}\pm0.01$	$214.70^{d}\pm1.41$	$98.00^{a}\pm0.71$	$5.51^{a}\pm0.01$	$77.50^{a}\pm0.14$
WPU3	65:20:15	$303.35^{b}\pm1.41$	$175.60^{d}\pm0.00$	$127.68^{c}\pm1.41$	$222.50^{c}\pm0.00$	$76.68^{b}\pm0.01$	$5.23^{c}\pm0.01$	$71.50^{e}\pm0.00$

The data are means± standard deviations of duplicate scores. Means within a row with different superscripts were significantly different ($p<0.05$).

Setback is a parameter that gives an idea about retrogradation tendency of starch in flour samples [43] ranges from 66.65 RVU to 98.00 RVU with WPU2 sample recording the highest value while WPF sample had the least value. Low setback is an indication that the starch has low tendency to retrograde or undergo syneresis [44]. Peak time is the time in minutes at which peak viscosity occurred. The peak time ranges from 5.23-5.51 minutes. Higher value was recorded for WPU2 and lower value was recorded for WPU3. Low peak time is indicative of the sample's ability to cook fast. This implies that WPU3 sample with lower peak time will cook faster than WPU2 sample. Pasting temperature is indicative of the minimum temperature required to cook or gelatinize the flour [45], 2005). The pasting temperatures ranged from 71.50 – 77.50oC. There was a significant differences ($P>0.05$) in the pasting temperatures among the samples, but WPU2 recorded higher pasting temperature. The result obtained from this study of pasting properties is in agreement with the one reported by [33].

3.4. Phytochemical Properties of Composite Flour

Phytochemical properties of composite flour are presented in Table 4.4. There was a significant difference at ($p<0.05$). Phytochemical properties ranged from 0.46-2.97 mg/100g saponins, 4.50-4.70 mg/100g flavonoids, 0.80-1.26 mg/100g tannins and 1.00-1.50 mg/100g phenols. WHF was recorded the highest tannins content. The result obtained from the study showed that all samples increase in the saponins, flavonoids and phenols content and decreased in the tannins as the ratio of wheat, unripe plantain and pigeon pea flour increases. There was no significant ($p<0.05$) difference among samples in terms of flavonoids.[39] reported higher tannins content of wheat, plantain and pigeon pea composite flour to be 10.23-13.02 mg/100g. The variation in result could be due to the variation in the species of wheat, unripe plantain and pigeon pea used. Phenols were not detected for WHF and WPF. The absence of phenol content in WHF and WPF could be due to the inclusion of pigeon pea as they are low in phenol contents. Higher value was recorded for WPU3.

Table 5 Phytochemical Properties of Wheat, Unripe Plantain and Pigeon Composite Flour

Sample code	Ratio	Saponins	Flavonoids	Tannins	Phenols
WHF	100:0	$0.46^{d}\pm0.14$	$4.50^{a}\pm0.14$	$1.26^{a}\pm0.01$	$0.00^{c}\pm0.00$
WPF	95:5:0	$2.18^{c}\pm0.01$	$4.50^{a}\pm0.14$	$0.80^{c}\pm0.01$	$0.00^{c}\pm0.00$
WPU1	85:10:5	$2.43^{bc}\pm0.14$	$4.60^{a}\pm0.14$	$0.81^{c}\pm0.01$	$1.00^{b}\pm0.00$
WPU2	75:15:10	$2.63^{b}\pm0.14$	$4.60^{a}\pm0.14$	$0.98^{b}\pm0.01$	$1.00^{b}\pm0.00$
WPU3	65:20:15	$2.97^{a}\pm0.01$	$4.70^{a}\pm0.14$	$0.96^{b}\pm0.01$	$1.50^{a}\pm0.14$

The data are means± standard deviations of duplicate scores. Means within a row with different superscripts were significantly different ($p<0.05$)

4. Conclusion

This study reveals that all the different flour blends contains all the functional properties in the right proportion to develop any leavened or unleavened breads, pastas, noodles, snack products and bakery products like cookies, pastries with sufficient nutrients from combination of unripe plantain and sprouted pigeon pea into whole wheat flour or refined wheat flour. The result showed that an increase in the unripe plantain and pigeon pea flour ratio of flour increased the protein, fiber, and fat content of the composite flour. The study also showed that flour formulation from different flour blends as was revealed for samples of wheat, unripe plantain and pigeon pea composite flour with ratios of 75:15:10 and 65:20:15 lead to improvement in functional properties, nutritional composition of the flour blends and reduced anti-nutrients drastically and therefore could be used for purposes of formulating food composition table to be used by food technologist.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to disclosed.

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